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PROPERTIES OF JETS IN Z EVENTS FROM 1.8 TEV $\bar{p}p$ COLLISIONS

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ABSTRACT

We have studied the properties of Z boson events produced in 1.8 TeV $\bar{p}p$ collisions using 19.3 pb^{-1} of integrated luminosity collected by the Collider Detector at Fermilab (CDF) during the 1992-93 Tevatron run. We compare the characteristics of the hadronic jets associated with the Z to leading-order QCD calculations using the VECBOS Monte Carlo program. For a subsample of events, we identify B jets and compare their rates to those expected from events with generic QCD jets.

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1. Introduction

The production of Z bosons in high energy $\bar{p}p$ collisions provides a clean sample of events in which the primary parton scattering process is well defined. These data can be used to test QCD calculations of the hadronic jet characteristics in Z events. In this analysis, the Z bosons are identified by their electron and muon decay modes. The VECBOS[1] Monte Carlo program is used to generate inclusive Z+n parton events, which are then fragmented and passed through a detector simulation. We compare various observed jet quantities to the VECBOS predictions and find generally good agreement.

2. The Z+Jets Event Sample

The $Z\rightarrow e^+e^-$ and $Z\rightarrow \mu^+\mu^-$ event samples are extracted from 1.8 TeV $\bar{p}p$ collisions with an integrated luminosity of 19.3 pb^{-1}, collected by the CDF detector[2] in the 1992-93 Tevatron run. Z candidates have one lepton passing tight selection cuts and the second identified using looser criteria. After an invariant mass window cut of $76.0<M_{ll}<106.0$ GeV/c^2 is imposed, 2046 Z candidates remain.

The Z sample is examined for jets using a CDF jet reconstruction algorithm[3] which clusters hadronic and electromagnetic energies in a cone of radius R=0.4 in $\eta - \phi$ space. The measured jet energies are corrected for a variety of instrumental effects. We require that the jets produced with the Z have $E_{T_{corr}} > 15$ GeV and $|\eta_d| < 2.4$, where η_d is the pseudorapidity measured from the center of the collision region.

3. Monte Carlo Generation of Z+Jet Events

We employ the leading-order QCD program VECBOS to generate Z+n parton events (n=1,2,3), using MRS D0' structure functions and $Q^2 = M_Z^2+p_{T_Z}^2$. The partons are converted to jets via HERPRT,[4] a color string fragmentation scheme as decribed by the HERWIG[5] shower program, which includes initial and final state gluon radiation. Finally the events are run through a CDF detector simulation, which models the response of the electromagnetic and hadronic calorimeters and the muon detectors. The resulting output undergoes the same analysis as the data. The Monte Carlo histograms are normalized to the number of events in each data sample.

4. Jet Production Properties in Z+Jet Events

The Z+jets data sample consists of 443 events. For events with multiple jets we order the jets in decreasing E_T.

The E_{T_1} spectrum for the Z+jet events is shown in Fig. 1. The histogram is the leading order QCD prediction. In Fig. 2, we show the $\cos\Theta^*$ distribution of the jet in all Z+1 jet events.

Correlated jet quantities are also investigated. VECBOS predicts that 50% of the Z+$\geq$3 jet events should fall above a line given by $E_{T2}+E_{T3} = 52$ GeV. Of the 17 data events, 7 fall above the line, consistent with prediction. Using the Z+$\geq$2 jet event sample, we examine the invariant mass spectrum M_{jj} of the two most energetic jets (Fig. 3), and the separation between these jets, given by $\Delta R_{jj} = \sqrt{\Delta\eta^2 + \Delta\phi^2}$ (Fig. 4). In all cases there is fairly good agreement between the predicted and observed distributions.

5. B-tags in Z+Jet events

The CDF collaboration has developed two tagging methods to search for B hadron decays in jets. The first (SVX tagging) uses CDF's silicon tracker to find secondary decay vertices; the second, soft lepton tagging (SLT), looks for the leptonic decays of b quarks.[6] These algorithms have been shown to be effective in identifying B hadrons and measuring their average lifetime.[6,7]

When we apply these B-tag algorithms to a sample of 7 Z events with $\geq$3 jets and $E_{T2}+E_{T3} > 52$ GeV, we find two events with SVX tags and none with SLT tags. The tags observed are compared to predictions made from the tagging rates measured for jets from generic QCD events. Applying these estimates to our subsample, 0.31 events are predicted to have SVX tags and 0.44 SLT tags, with an uncertainty of about 15%. Adding the SVX and SLT tags, 0.75 tags are predicted and 2 observed, a probability of 18%. Therefore we see no statistically significant excess heavy flavor content in the jets from our events over that observed in generic QCD jets.

6. Summary

The properties of QCD jets produced in association with Z bosons in 1.8 TeV $\overline{p}p$ collisions have been measured using the CDF detector. Various characteristic quantities of the jets are compared to leading order QCD predictions as generated with the VECBOS Monte Carlo program, and in general are found to be in good agreement. The jets in a sample of events with $\geq$3 jets and high sum E_T have been examined for B hadrons. The tag rate observed is consistent with that predicted from generic QCD jets.

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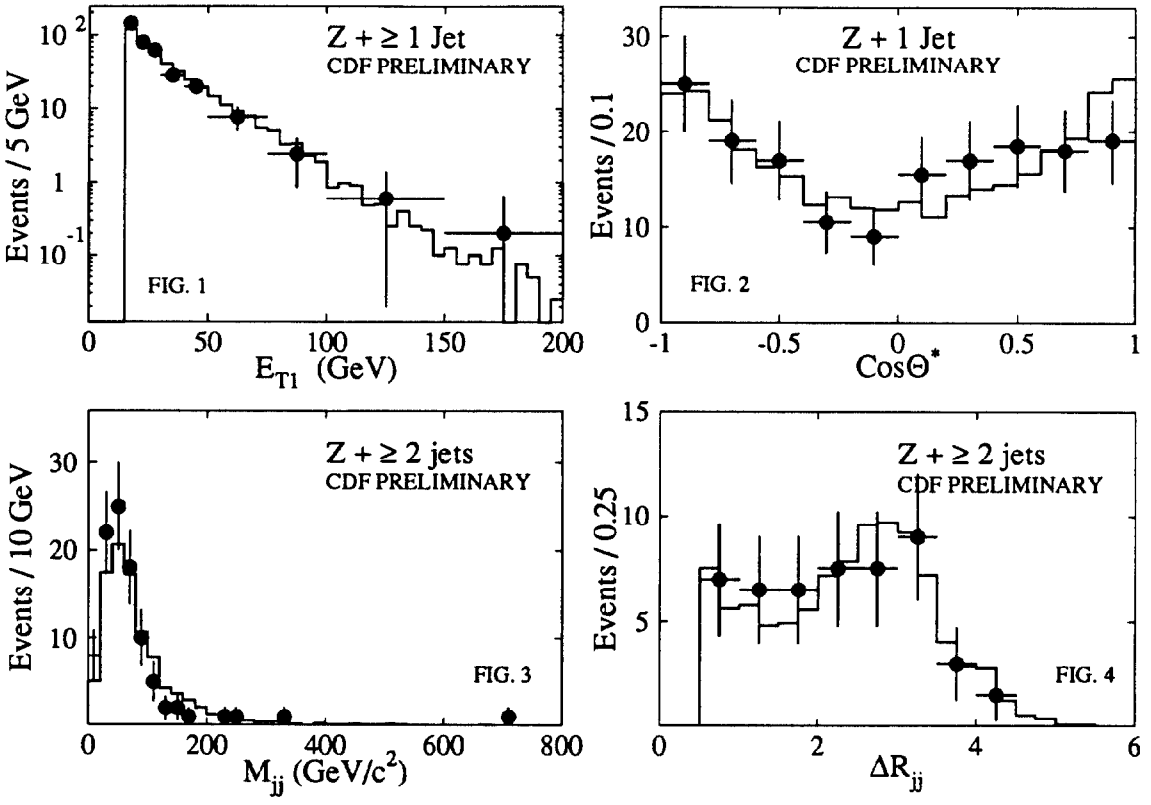

Fig. 1 The E_{T1} spectrum for Z+jet events (VECBOS prediction shown as histogram)
Fig. 2. The cosΘ^* distribution of the jet in Z+1 jet events
Fig. 3. The M_{jj} spectrum for Z+≥2 jet events
Fig. 4. The ΔR_{jj} distribution for Z+≥2 jet events.